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Marine Casualty Investigations

Enquêtes sur les accidents maritimes

# Investigation Report to the Minister pursuant to sections 542 or 545 of the Canada Shipping Act

# Rapport d'investigation au Ministre conformément aux articles 542 ou 545 de la Loi sur la marine marchande du Canada

Canada

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# REPORT OF INVESTIGATION INTO THE CIRCUMSTANCES ATTENDING THE SINKING OF THE CANADIAN FISHING VESSEL "COREY & AARON", AT SEA OFF NOVA SCOTIA, DECEMBER 2, 1987.

## REPORT No. 508

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**REPORT OF INVESTIGATION INTO THE CIRCUMSTANCES ATTENDING THE SINKING OF THE CANADIAN FISHING VESSEL "COREY & AARON", AT SEA OFF NOVA SCOTIA, DECEMBER 2, 1987.**

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## Particulars of Vessel

| | |
|---|---|
| Name | "COREY & AARON" |
| Official Number | 809424 |
| Port of Registry | Yarmouth, Nova Scotia |
| Gross Tonnage | 26.70 |
| Net Tonnage | 17.51 |
| Length | 12.01 m |
| Breadth | 4.94 m |
| Depth | 2.10 m |
| Departure Draughts (Calculated) | 1.89 m aft<br>0.56 m forward |
| Type | Cape Island type, open fishing vessel, moulded reinforced plastic hull |
| Built | 1987 |
| Propulsion | 320 BHP Caterpillar diesel driving one fixed-pitch propeller |
| Cargo/Fishing gear | 240 lobster traps and gear weighing approximately 6.856 tonnes |
| Crew | Four |
| Owner | David Karl Muise<br>Pubnico, Nova Scotia |

## Navigating Equipment

| | |
|---|---|
| Radar | Sitex, ranges 0.25 to 32.0 miles |
| Loran C (1) | Sitex |
| Loran C (2) | Sitex |

| | |
|---|---|
| Echo sounder | Sitex (colour) |
| Compass | Wagner |
| Auto pilot | Wagner |

**Communication Equipment**

| | |
|---|---|
| VHF Radiotelephone | Sitex 0-80 channels |

**Lifesaving Equipment**

| | |
|---|---|
| Liferaft | Dunlop inflatable, 4 persons, last serviced September 1987. |
| Lifebuoys | 1 with 27 m of line |
| Lifejackets | 4 approved keyhole type, adult |

**Pumps**

| | |
|---|---|
| Rule 3500 (electric) | Situated in bilge (aft) non-automatic |
| Rule (hand) | Situated in engine-room bilge |

**Description of Vessel**

The "COREY & AARON" was typical of the many inshore fishing vessels which operate off the southeast coast of Nova Scotia. She was of open construction, reportedly built to the approved specifications of the Cape Islander design; her hull was transversely divided into three compartments, namely, accommodation forward, engine-room amidships in which the hand pump was situated and a void space aft through which the propeller shaft ran and in which the electric bilge pump was situated. (See Figure No. 1.)

Four centre line flush inspection hatches in the well-deck, each approximately 60 cm x 60 cm, gave access to the void space. The well deck was located approximately 0.66 m below gunwale level at amidships and extended aft to the transom.

Four circular scupper holes were fitted through the shipsides, two on each side, to facilitate drainage; they were each 10 cm in diameter and situated at the mid length of the well deck; they were capable of being closed by plastic screw plugs.

The vessel was in possession of a valid Steamship Inspection Certificate (SIC 29) certified to ply on Home Trade Voyages Class III, not more than 20 miles offshore, issued at Abbotts Harbour, Nova Scotia, on October 31, 1987, due to expire October 30, 1991.

**NOTE:** (1) All times in this report are expressed in Atlantic Standard Time (UTC minus 4 hours).

(2) A Glossary of abbreviations and terms can be found following the Findings in this report.

## Background

The "COREY & AARON" departed Abbotts Harbour, near Pubnico, Nova Scotia, during the morning of December 2, 1987 enroute to lobster fishing grounds some 13 miles west of Pubnico.

The lobster fishing season had recently begun and the vessel was making her first voyage since building. She carried 240 baited lobster traps on deck which were to be set at the grounds.

When approaching the grounds the vessel capsized and sank in 10 fathoms of water in good weather conditions and in position approximate 43°30'N, 66°05'W, becoming a total loss. She was valued at some $140,000.

There were no injuries as a result of this casualty. Pollution was minimal consisting of the vessel's diesel fuel oil.

There are, potentially, a large number of similar fishing vessels at risk of a similar casualty.

## Narrative

The "COREY & AARON" was a new boat and she sank after only 2.5 hours had elapsed during her maiden voyage.

The lobster fishing season had opened on November 30 and for the 3 days prior to that the vessel had been loaded with 240 lobster traps and associated gear, all stowed but not secured, on the well deck. The four circular scupper holes were left unplugged, reducing the effective freeboard to 23 cm in the loaded departure condition.

It was intended to proceed to the fishing grounds on the

first day of the season; however, gales had caused the seas outside of the harbour to be too rough and the trip was delayed for 2 days until the seas moderated. In the meanwhile, the "COREY & AARON" lay at anchor, in the harbour.

At 0530, December 2, the vessel departed Abbotts Harbour with four people on board; i.e., the owner/operator and three deck-hands. The weather was fine and clear with unlimited visibility; the wind was westerly at approximately 6 knots causing slight to moderate seas of 0.3 to 0.6 m and there was a long low swell caused by the previous gales; the sea and air temperatures were both 7°C.

At 0730 approximately, some 30 minutes before sinking and while travelling at full speed, the crew heard a distinctive cracking sound which they believed to come from the region of the hull. Because the crew was not used to plastic hulled boats the sound was attributed to an abnormal wave contacting the hull, consequently neither the accommodation nor the engine room were examined in order to ascertain hull damage; the void space and well deck could not be examined due to the stow of traps.

At approximately 0755 while the vessel was approaching the fishing grounds (see attached copy CHS chart 4012) on reduced speed and awaiting the ebb tide before starting to set the traps, it was noticed that the vessel had developed a list to port. Being unable to see the well deck due to it being completely covered by the stowed traps which also reached to a height of some 2.0 m and, believing that the stow might have shifted, the owner/operator directed one of the deck-hands to climb onto the wheel-house top in order to determine the condition of the stow; the engine was then stopped.

The stow of traps was seen to be in place; however, after stopping the engine and as the vessel slowed, the port list progressively and rapidly developed; it was decided to abandon and all four crew members donned lifejackets, the VHF radiotelephone was used on channel 79 to transmit a 'MAYDAY' call which in effect stated that the "COREY & AARON" was sinking, that the crew were abandoning and required assistance.

The inflatable liferaft was launched on the port side and while it was inflating the vessel listed to such an extent that lobster traps started to dislodge and fall over board. By the time the crew had entered the liferaft, estimated at 4 minutes from the time of stopping the engine, the "COREY & AARON" had listed some 90° and most of the traps had fallen into the sea; from then the vessel quickly settled

by the stern and sank stern first, the bow being the last part to submerge. The time was estimated to be 0800 December 2, 1987.

The crew stayed in the liferaft and was rescued by another fishing vessel, which was close at hand, some 2 minutes after they had abandoned and the crew was later transported back to Abbotts Harbour.

## Analysis

### 1. The "COREY & AARON"

The "COREY & AARON" was typical of many GRP fishing boats which have recently been built in Nova Scotia to replace older wooden-hulled boats which have aged beyond viable maintenance costs.

The evolution of the traditional wooden 'Cape Islander' type from which the design of the "COREY & ARRON" developed was such that the earlier boats employed in the inshore fishery were normally under 15 gross tons, and therefore uninspected. Generally they were classed "of open construction", meaning that they were not decked-in or permanently enclosed at or above gunwale level for more than 50% of their length. Being relatively small they were usually operated with careful regard for weather. The deck, located below the gunwale and forming a well, was not watertight and any water which found its way aboard over the gunwales, drained to the bilges, from where it was pumped out. In the case of the "COREY AND AARON", she was 26 gross tons, and therefore required to be inspected; the well deck (cockpit sole) was watertight and the only means of drainage were two 10 cm diameter scuppers through the shipside on each side near amidships.

The proportions of many of the recently moulded GRP hulls differ significantly from the traditionally accepted normal practice, and the ratios of breadth, depth, carrying capacity and gross tonnage relative to vessel length, have all increased. The "COREY & AARON" was considered to be capable of carrying twice the load of the owner's previous boat which was of wooden construction, the greater size reducing the number of trips to the fishing grounds by half for the same number of traps.

## 2. Construction "COREY & AARON"

The hull, or shell, of the "COREY & AARON" consisted of moulded, reinforced plastic; this was the first part of the boat to be built and was completed at a local boat yard during June 1987. The owner/operator purchased the shell and had it transported to a location nearer his home where he and another fisherman/boat builder completed the construction. The completion consisted of manufacturing and fitting the decks and all interior fittings such as bulkheads, deep-floors, beams, accommodation, navigational equipment, engine and propeller, etc. Reportedly, the construction closely followed directions given on a set of standard plans approved by the Canadian Coast Guard, Ship Safety Branch (CCG, SSB), which were provided to the owner by the shell builders.

The Small Fishing Vessel Inspection Regulations are made pursuant to the Canada Shipping Act and requires and that, before construction of any vessel exceeding 15 tons gross tonnage is begun, the owner submit plans and/or detailed scantlings lists of the proposed construction to the CCG, SSB in order that they may be approved; the construction then follows the approved plans. Provided the requirements are met and periodic inspections by a CCG, SSB surveyor are satisfactorily completed, the vessel is then issued with a Steamship Inspection Certificate which is subject to renewal at intervals of 4 years.

Section 381 of the Canada Shipping Act states:

> ...It is the duty of the owner to have such inspection made and no such steamship shall be so used unless there is on board and in force a certificate...

The shell builders provided the owner with approved standard plans and believed that he would advise the CCG,SSB of his intentions to complete the vessel. The owner/operator believed the shell builders would advise CCG,SSB. Consequently no one advised them and the fact that the "COREY & AARON" was building only came to their notice when the manufacturers of a fuel tank destined for the "COREY & AARON" requested an inspector to witness a hydrostatic test on the tank. Inspections were carried out from that time but the "COREY & AARON" had reached an advanced stage of construction with all internal strength members in place and secured by plastic laminations, therefore, the number of laminations used could not be determined. Neither could it be

determined how closely other construction had followed the specifications in the approved plans.

The "COREY & AARON" was issued with a certificate (SIC 29) by a steamship inspector after satisfactory dock and sea trials.

## 3. Stow of lobster traps

The 240 traps consisted of 160 wooden and 80 wire traps; the wooden traps each weighed some 31.78 kgs and the wire traps some 15.89 kgs, producing a total weight of approximately 6,356 kgs.

In addition to the traps there was approximately 6,400 m of 13 mm diameter polypropylene rope used to secure and buoy each string of 20 traps; it is estimated that the rope, together with some 20 buoys, weighed a further 500 kgs.

The wooden traps and their ropes were stowed in 5 tiers on the well deck, the first 2 tiers consisted of 40 traps in each; they were stowed fore and aft, five to each length and eight across. The third tier contained 35 traps stowed five to each length and seven across. The fourth tier five to each length and six across. The fifth tier was stowed five across and contained the balance of 15 wooden traps and some wire traps. The remaining 60 or so wire traps were stowed in the space remaining between the wheel-house after bulkhead and stow of wooden traps. (See Figure No. 1.)

The total height of the stow was estimated to be some 2 m, completely covering and precluding any view of the well deck.

The stow was not secured and the nature of the stow and the characteristics of the traps were considered adequate to prevent their becoming dislodged.

## 4. Scupper holes (drainage holes)

A total of four circular scupper holes, each 10 cm in diameter, were fitted into the boat's sides, two on each side and at the mid length of the well deck (see photograph); they were situated at well deck level and were capable of being closed by plastic screw plugs. Their purpose was to allow wash deck water and water shipped over the gunwales to drain off the well deck and overboard. They were left open during the time at anchor and during the voyage. Reportedly, the scuppers

were left unsecured because that was the usual previous practice adopted by the skipper when sailing in smaller vessels of traditional wooden construction.

The scupper holes were not shown on the standard approved plans and their installation some 0.66 m below gunwale level ensured that whenever they were unsecured, the vessel's effective freeboard was drastically reduced, making her highly susceptible to shipping water, particularly when heavily laden. The watertight construction of the well deck with no means of drainage to the bilge and therefore to the only pump suctions, precluded the clearing of water shipped either via the scupper holes or over the gunwale. This hazardous situation is one to which all similarly outfitted vessels of open construction would be subjected if employed offshore with unsecured scuppers. On the other hand, if shipside scuppers are not fitted or are kept closed while at sea, any water shipped over the gunwales and retained on a watertight well deck, also endangers the vessel.

It is apparent from the contradictory situations described above that all small vessels of open construction are inherently susceptible to the dangers of swamping, are therefore very weather dependent, and require prudent operation.

## 5. Drainage and discharge of shipped water

The necessity for the rapid and effective clearing of shipped water from the weather parts of working decks is addressed in Section 29.1 of Part 1 of the Small Fishing Vessel Inspection Regulations. (See Annex No. 1). These regulations are applicable to vessels of more than 15 GRT of both 'open' and 'closed' construction, and in calling for the provision of minimum freeing port areas in way of wells on exposed working decks, it is implicit that sufficient effective freeboard must be maintained to allow the rapid clearing of any shipped water.

On vessels of 'closed' construction where the working deck is at gunwale level, the retention of a sufficient effective freeboard is not as critical as it is in the case of vessels of 'open' construction where the working deck, i.e. well deck, is located below gunwale level, such that, when the vessel is heavily loaded, the well deck is close to, or at, the trimmed waterline.

Any small fishing vessel of open construction employed offshore in exposed waters is operated at some risk,

being particularly vulnerable to swamping by taking seas over the gunwale, and prudent operation with regard to loading, handling and weather is essential for safety.

The Small Fishing Vessel Inspection Regulations address the provision of freeing port area in bulwarks on fishing vessels of 'closed' construction. They do not specifically address the drainage of water from watertight cockpits or wells on fishing vessels of 'open' construction.

Regulations have an important part to play by ensuring a minimum safe construction standard; in this regard, the Small Fishing Vessel Inspection Regulations are currently the subject of revision and are about to be rewritten. There are a considerable number of new GRP fishing vessels exceeding 15 GRT under construction, some of which are of 'open' design.

## 6. Draught, trim and freeboard

The "COREY & AARON" was heavily loaded with 2,362 litres of fuel, in three tanks, and 240 lobster traps, together with their attendant cordage and buoys.

There are no regulations which govern the draught or trim to which a fishing vessel may be safely laden with either fish or gear, therefore, prudent loading is left to the judgement of the operator and crew.

After the "COREY & AARON" had been loaded, the freeboard (distance from well deck edge to waterline) was measured by the operator and found to be 23 cm in way of the scupper holes and 15 cm at the stern. The draught forward was estimated to be 0.45 m and the draught aft to be 1.38 m. However, the vessel was not fitted with draught marks and post-casualty calculations show that, after allowing for the pronounced designed rake-of-keel, the actual draughts to the underside of keel were approximately 0.56 m forward and 1.89 m aft. (See Figure No. 1.)

## 7. Weather and boat's motion

The vessel was heading into moderate seas of some 0.3 m to 0.6 m and reportedly pitching and rolling slightly.

## 8. Cracking sound

The cracking sound was not given any importance as it was believed by the crew, who were not familiar with the

characteristics of plastic hulled boats, to be related to a wave motion against the hull and not to structural damage. However, had the engine space been inspected at that time, or on a continuing basis from departure, then the presence of any water would have alerted the crew to the possibility of damage and of a greater depth of water (due to the stern trim and hull configuration) in the void space.

A search of MCI computerised statistical data for casualties reported since 1975, concerning GRP fishing vessels on the Eastern seaboard of Canada, showed that of the several hundreds in service, there was only one casualty involving a 'hull crack'. In that instance the hull shell failure did not occur independently, but was brought about by localised stresses due to buckling of the stern while at sea.

The soundness of any completed GRP vessel is dependent upon the quality of the shell moulding in combination with thoroughness of the subsequent fitting-out; shortcomings in either or both phases of construction could lead to structural failure in service. MCI has received some recent reports where framing, knees, floors, bulkheads and engine bearers were poorly constructed and inadequately matted-in during the fitting-out stage; these vessels were not lost at sea, but could not continue fishing operations because of vibration, shell, deck and bulkhead buckling etc. In another instance a poorly matted-in transverse wooden bulkhead is known to have pulled away from the inside of the moulded shell, causing damage to the hull, but fortunately not initiating any ingress of water.

## 9. Characteristics of the sinking

Consideration has been given to the cause of the casualty being a breach in the hull, such as a hull fracture or leakage at a through-hull fitting; however, in that case the probability would have been for the vessel to noticeably settle in the water and trim more by the stern without incurring a list, as her buoyancy was lost and floodwater collected in the deep trough formed by the moulded keel. The volume of the trough formed by the moulded keel and skeg in way of the void space and engine-room was capable of holding some 3 tonnes of seawater. The configuration and width at the top of the trough, even if flooded to near capacity, was such that no significant free-surface effect would be created.

The first indication of anything amiss aboard the vessel was when she suddenly developed a list which rapidly increased until it had reached an angle of some 90°. The vessel was on her 'beam ends' before she finally settled by the stern and sank. These characteristics are more typical of a sudden and dramatic loss of transverse stability due to the presence of a substantial free-surface effect, and subsequent shift of slack liquid.

10. Conditions leading to downflooding of the hull

Reportedly, four inspection hatches were located on the centreline of the well deck and arranged to give access to the void space for the installation and servicing of the propeller shafting, stern tube and oil fuel piping etc. The opening of each was approximately 60 cm x 60 cm, and covers of GRP sheathed plywood of similar scantlings to the deck were arranged to fit into recesses so that when secured, their upper surface was flush with the well deck. The plywood covers were intended to be laid on a waterproof sealant and secured around their perimeters by flat head wood screws passing through the covers and driven into the wooden boundary framing of the recesses.

Prior to loading the traps and gear, the four centre line inspection hatches in the well deck were reportedly closed by having their covers placed in the recesses, thus making the well deck flush and apparently watertight.

One of the hatch covers was screwed down but the others were not; it was believed that the weight of traps and gear stowed on top of them would retain them in their recesses and keep the deck watertight.

In this regard, Part 1, Section 24.2 of the Small Fishing Vessel Inspection Regulations states:

> 24.2 Where a shaft tunnel access cover is fitted in a fish hold, it shall be fitted and secured in such a manner as to prevent dislodgement.

While the above specifically addresses access covers located in fish holds, similar precautions are equally necessary for access covers fitted on exposed watertight decks upon which the fish catch is routinely carried, subject to the provision of separate and suitable means of drainage from those decks.

Although the motion of the vessel was reportedly slight as she headed into the 0.3 to 0.6 m waves, the freeboard of 23 cm in way of the unsecured scupper holes would frequently be lost as the vessel passed through the waves, allowing water onto the well deck. The submerging of the scupper holes would also be increased frequently due to 'heave'; i.e., the vertical bodily motion of a vessel in a seaway, causing further seawater to be shipped.

Depending on the degree of pitching, it is also possible that water was occasionally shipped onto the well deck by spray or waves washing over the gunwales and transom. Sea water shipped and retained on the well deck would become entrapped among the traps and gear stowed at the after end, thus increasing the trim by the stern and lessening the clearing capability of the scupper holes. The increasing weight would decrease freeboard and the entrapped water reduce stability due to free-surface effect, the whole situation becoming progressively worse.

After the vessel had listed and the stow of traps and gear had shifted, the centre line hatch covers would dislodge allowing downflooding from the well deck into the void space, causing further free-surface and loss of stability.

Provided the well deck was soundly constructed with scantlings, materials and fastenings in accordance with the approved plans, calculations show that it was capable of absorbing the distributed weight of the reported load of lobster traps and fishing gear. Furthermore, excessive deck loading from shipped water of a depth sufficient to cause structural failure is unlikely to have been attained before the concurrent free-surface effect of a much shallower level of flooding overcame the vessel's transverse stability. Consequently, unless a localized failure in way of a through-deck fitting or fastening occurred from any excessive and undetected vibration or hull flexing, damage-related downflooding is considered unlikely to have contributed to the loss of the vessel.

## 11. Pumps

Of the two pumps on board the "COREY & AARON", one was hand operated and situated in the engine-room bilge at the centre line, the other was electrically operated and situated in the void space bilge at the centre line abreast of the well deck scuppers.

In many wooden vessels of this type, the well deck is not watertight and the electrically operated pump is automatic, switching on when the water level in the bilge reaches a pre-determined height. In the case of the "COREY & AARON", the pump was not automatically operated because it was believed that the construction of the well deck was such that its watertightness did not require an automatic pump; the existing bilge pump was to be used for pumping any slight seepage of water through the hatches which might occur during fishing operations or in the event of a hull fracture or faulty through-hull fitting.

The electric pump was used prior to departing the harbour and the boat found to be dry, however neither pump was put to use from that time, nor was the engine space examined in order to determine if any flooding had occurred. The rapidity of sinking precluded all but the sending of a 'MAYDAY' and the abandoning of the vessel.

## 12. Salvage

The location of the "COREY & AARON" was determined and two unsuccessful attempts at salvage made by the owner and other local fishermen. Considerable damage to the hull and superstructure was reportedly incurred during these attempts and no further salvage operation is contemplated.

The success rate for salvaging fishing vessels in similar circumstances to the "COREY & AARON", in MCI's experience, is poor. For the undertaking to be successful, it has to be professionally planned and executed and even then, the success of the exercise is always very dependent on weather.

## 13. Stability

As a small fishing vessel of open construction exceeding 15 gross tons and not engaged in fishing for capelin or herring, the "COREY & AARON" was not required to comply with the intact stability requirements of Part 1, Section 29, of the Small Fishing Vessel Inspection Regulations. Regulatory approval is based upon compliance with criteria detailed in Canadian Coast Guard 'Stability, Sub-division and Load Line Standards', STAB.4, and although the "COREY & AARON" was not required to comply with these requirements, they are considered to be the most appropriate 'yard-stick' against which the stability characteristics of fishing vessels of this size may be assessed, notwithstanding

the mode of fishing in which they may be employed.

The actual criteria contained in STAB.4 are given in Annex I of this report. Direct comparison of the minimum required values with the results of the post-casualty stability analysis of the "COREY & AARON" are included in this section of the report.

Details of the vessel's hull form were recorded by the builders of the hull shell moulding and a lines plan of the standard vessel was prepared in June 1987, but no basic design data, cross-curves or hydrostatic particulars were developed. The vessel was not, nor was she required to be, the subject of an inclining experiment and consequently her precise stability characteristics, upon completion by her owner, were unknown.

In order to determine the transverse stability of the "COREY & ARRON" at the time of the casualty, her lightship weight and centre of gravity were derived from the results of an inclining experiment performed on a sister-ship "MYSTIQUE LADY", on May 4, 1988. The fibre-glass hull of the sister-ship was from the same mould as that of the "COREY & AARON" and, while the make and model of the main engines differed, their locations and overall as-fitted weights were similar. The basic scantlings and layouts of both vessels were based upon the same standard finishing plan provided by the moulding supplier, and the only significant difference between the vessels was in the capacity and location of their oil fuel tanks. The derived lightship characteristics, incorporating due allowances for the minor differences between the two vessels, together with the reported oil fuel, fishing gear and baited lobster traps onboard the "COREY & AARON" on departure, were combined to re-create the vessel's actual loading condition just prior to her loss. The reported deadweight, loading details and calculated trimmed draughts are shown in Figure No. 1, and substantially confirm the well deck freeboards recorded by the owner prior to the vessel's departure.

A post-casualty stability analysis was carried out which focused upon the influence on the vessel's transverse stability of the weight and height of the lobster traps stowed above the well deck, together with the assumed detrimental free-surface effects of the water shipped and retained onboard.

As a vessel of open construction, the reserve buoyancy and range of positive stability of the "COREY & AARON"

were dependent upon the ship's sides being intact up to gunwale level. In such case, calculations show that on departure the vessel's metacentric height (GMf), maximum righting lever (GZf), and total dynamic stability would have been 1.91 m, 0.54 m @ 25.18°, and 0.146 mR, and that positive transverse stability was maintained up to the point of gunwale immersion at an angle of heel of approximately 25.2°; substantially exceeding the minimum requirements of STAB.4 in all but the requirement for total positive range. However, because the scuppers were unsecured the effective freeboard was reduced to 0.23 m, and consequently slight pitching and moderate rolling of only 5.35° would have caused the scuppers to be immersed and water to be shipped on the well deck. As the effectiveness of the scuppers was intermittently impaired, due to wave action and some 'rolling under', the shipped water would not be continuously cleared and because of the watertight construction of the well deck and the initial after trim of the vessel it would have accumulated across the full breadth of the well deck aft. It is also likely that some of the shipped water downflooded into the void compartment below the well deck by way of the loosely positioned covers of the unsecured flush inspection hatches.

In general, few fishermen understand free-surface effect and fewer appreciate the substantial reduction of initial transverse stability brought about when water, even a few inches deep, is shipped and retained on deck or allowed to accumulate in underdeck compartments. The transverse stability of a vessel is adversely affected because the presence of any liquid which is free to flow to port and starboard causes a virtual rise of the vessel's centre of gravity, the predominate influence being due to the breadth of the free-surface, while the actual quantity of liquid is usually of secondary concern.

Because of the increasing after trim brought about by the accumulation of shipped water, the fluctuations in its depth and distribution, and the partial interference to its free-flow due to the framework of the bottom layer of traps, the actual quantity and extent of entrapped water cannot be precisely determined. However, it can be conservatively assumed that a 'nominal' layer only 75 mm (3") deep accumulated on the well deck, as shown in Figure No. 1, and a realistic estimate of the vessel's transverse stability just before the casualty may thus be made.

Calculations show that the weight and free-surface

effect of the 'nominally' shipped water reduced the existing effective freeboard, increased the after trim and caused a drastic reduction of the vessel's transverse stability. In this loading condition, the vessel's metacentric height (GMf) was reduced to 0.28 m, the maximum righting lever (GZf) to 0.044 m @ 14.5°, and the total dynamic stability to 0.0041 mR, while the range of positive stability was lowered to approximately 18.75°. These criteria represent the vessel's most likely condition shortly before the capsize and show that the GMf, GZf and total dynamic stability, were respectively only 80%, 22%, and 4.5% of the minimum standards required by STAB.4. Calculation also shows that gravitation of only one quarter of the 'nominal' layer of shipped water from starboard to port, brought about by the vessel's rolling motion, would initiate heeling, submerge the portside scuppers and reduce the maximum righting lever to virtually zero.

It should be noted that these transverse stability characteristics are based upon the 'ideal' static sea state. In actual dynamic sea conditions, angles of roll are usually greater than calculated by 'static' methods and, because of the uneven effects of wave motion and ship speed, the calculated reserve dynamic stability of small vessels is subject to considerable fluctuation.

It would appear that while the "COREY & AARON" was in the highly vulnerable condition indicated by the above characteristics, the dynamic heeling effect caused by the shipped water gravitating to port overcame her initial stability. The vessel, having been rolled by the momentum of the sudden transverse flow of slack water toward the limiting range of positive stability, tended to remain heeled over to port for some time, while water continued to flood onto the well deck through the submerged scupper holes. When the port side gunwale became immersed, the sudden increase in the rate and quantity of water being shipped prevented the vessel's recovery; heeling continued and all positive transverse stability was lost. Subsequently, the shipped water downflooded into the void compartment by way of the unsecured inspection hatch covers and progressed into the wheel-house, engine-room and forward crew space, until all reserve buoyancy was lost and the vessel sank.

In simple terms, the heavily laden "COREY & AARON", capsized, downflooded and sank because of the reduction of transverse stability brought about by the free-surface effect of seawater shipped and retained on the

watertight well deck. The water was initially shipped because of the low freeboard in way of the unsecured well deck scupper holes; consequently, the vessel did not retain sufficient transverse stability to withstand the dynamic heeling forces imposed on her in the prevailing moderate weather conditions.

14. **Communications**

(a) **Ship station radio licence**

Being under 20 m in length, the "COREY & AARON" was not required by regulation to carry a VHF radiotelephone or in fact any radio communication apparatus; nevertheless, a vessel which does carry radio apparatus must have a radio station licence as directed by the Minister of Communications and as required by the Radio Act. The "COREY & AARON", which carried a VHF radiotelephone, did not have such a licence.

(b) **Radio operator's certificate requirements**

Sections 78 and 88 of the General Radio Regulations Part II made pursuant to the Radio Act state in part:

> 78. The apparatus of all radio stations shall be worked only by operators holding a Canadian certificate of proficiency ...
>
> 88. The holder of a Restricted Radiotelephone Operator's Certificate (Maritime) may act as a radiotelephone operator on ship station, ...

None of the crew of the "COREY & AARON" held the required certificates.

(c) **International distress, safety and calling frequency VHF Channel 16**

Whilst the monitoring of VHF Channel 16 is mandatory for vessels required by regulations to be equipped with a VHF set, vessels voluntarily so equipped should, in the interest of safety, also endeavour to monitor this international distress, safety and calling frequency.

The section on 'distress communication' contained in a DOC publication entitled 'A guide for the

radiotelephone operator', stresses the need for the use of VHF channel 16 for initiating a distress message and states in part:

Distress Communications

Frequencies to be used

The first transmission of the distress call and message by a vessel should be on the distress, calling and answering frequency of 2182 kHz (MF) or Channel 16, 156.800 MHz (VHF). If no response is heard on these frequencies, the use of any other available frequency in an effort to obtain assistance is permitted.

All Canadian Coast Guard Radio Stations monitor and record channel 16, and a 'MAYDAY' transmitted on the frequency would immediately alert a radio station and thus the SAR organisation. Further, in the case of a rapid or indistinct message, playback of the recording permits a correct interpretation of its content.

As is typical for those engaged in fishing operations, the only radiotelephone frequency in constant use by the local fishermen was one designated for use in ship to ship communication, in this case, channel 79. The 'MAYDAY' was heard by other fishing vessels using channel 79, one of whom relayed the distress signal to a Canadian Coast Guard Radio Station on the designated distress, safety and calling frequency, VHF channel 16. The radio station in turn advised the Rescue Coordination Centre (RCC) at Halifax, Nova Scotia.

Although the safe rescue of the crew of the "COREY & AARON" was quickly accomplished by another fishing vessel which had heard the 'MAYDAY' on channel 79 and the assistance of RCC was not required in this instance; if the 'MAYDAY' had not been heard, understood and responded to by other fishing vessels using that channel it could not have been relayed to the SAR organization. In similar situations in the past, this has led to disastrous consequences.

15. Lifesaving equipment

Paragraph 30 subsection (2) of the Small Fishing Vessel Inspection Regulations states:

> Every fishing vessel of open construction not exceeding 12.2 m in length shall carry

(a) one approved lifejacket for each person on board

(b) one approved lifebuoy fitted with 27 m of line

The "COREY & AARON" met the above requirements and in addition, although not required by regulation, carried a four man capacity inflatable liferaft.

It should be noted that, had the vessel been of 'closed' construction, she would have been required to carry a liferaft by regulation.

The performance of the equipment was as follows:

| | |
|---|---|
| Lifejackets | All four were used and found satisfactory however immersion was minimal during boarding the liferaft. |
| Lifebuoy and line | Not used. |
| EPIRB | None required by regulation and none carried. |
| Immersion suits | None required by regulations and none carried. |
| Radiotelephone | One VHF radiotelephone, Sitex, (not required by regulation) was carried and used to alert other fishermen to the distress. |

## 16. Crew qualifications and experience

The owner/operator held no formal marine qualifications nor was he required to by regulation. He had been fishing for some 20 years and had owned his own boat for the previous 7 years.

All three deck-hands were experienced fishermen and had fished with the owner/operator for the previous 7, 5 and 4 years, respectively.

## Findings

The Canadian fishing vessel "COREY & AARON" sank during her maiden voyage, in moderate weather conditions while

enroute to fishing grounds, heavily laden with lobster traps and gear.

Acknowledging that a post-casualty inspection of the vessel was not possible and thus a precise cause determined, of the various options, it is considered that the most likely reason for the loss of the vessel was an accumulation of water on deck. Accepting this theory then the following would appear to be contributing factors:

- the scupper plugs were not fitted,
- the open scupper holes and consequent low effective freeboard allowed sea water access to the well deck contrary to their designed function, namely to clear the well deck of water,
- the water shipped on deck tended to gravitate aft, trimming the vessel further by the stern,
- sea water which accumulated and became entrapped on the well deck caused a free-surface effect and drastically reduced the vessel's initial transverse stability,
- the entrapped sea water gravitated to one side of the well deck causing the vessel to list and submerge her scupper holes and sequentially her gunwales which further increased the flow of water onto the well deck, and
- the unsecured centre line inspection hatch covers became dislodged, allowing down-flooding of the void space and the total loss of reserve buoyancy.

**Other Findings**

The present Small Fishing Vessel Inspection Regulations for vessels over 15 gross tons of 'open' construction do not adequately cover the provisions required to rid the vessels of water taken on deck.

The owner of the "COREY & AARON" did not request Coast Guard inspection of his vessel at an early stage of construction.

None of the Coast Guard approved plans, on which the construction of the "COREY & AARON" was based, included details of any specific means for the removal of shipped water from the watertight well deck.

The "COREY & AARON" did not have a radio station license as required by the Radio Act.

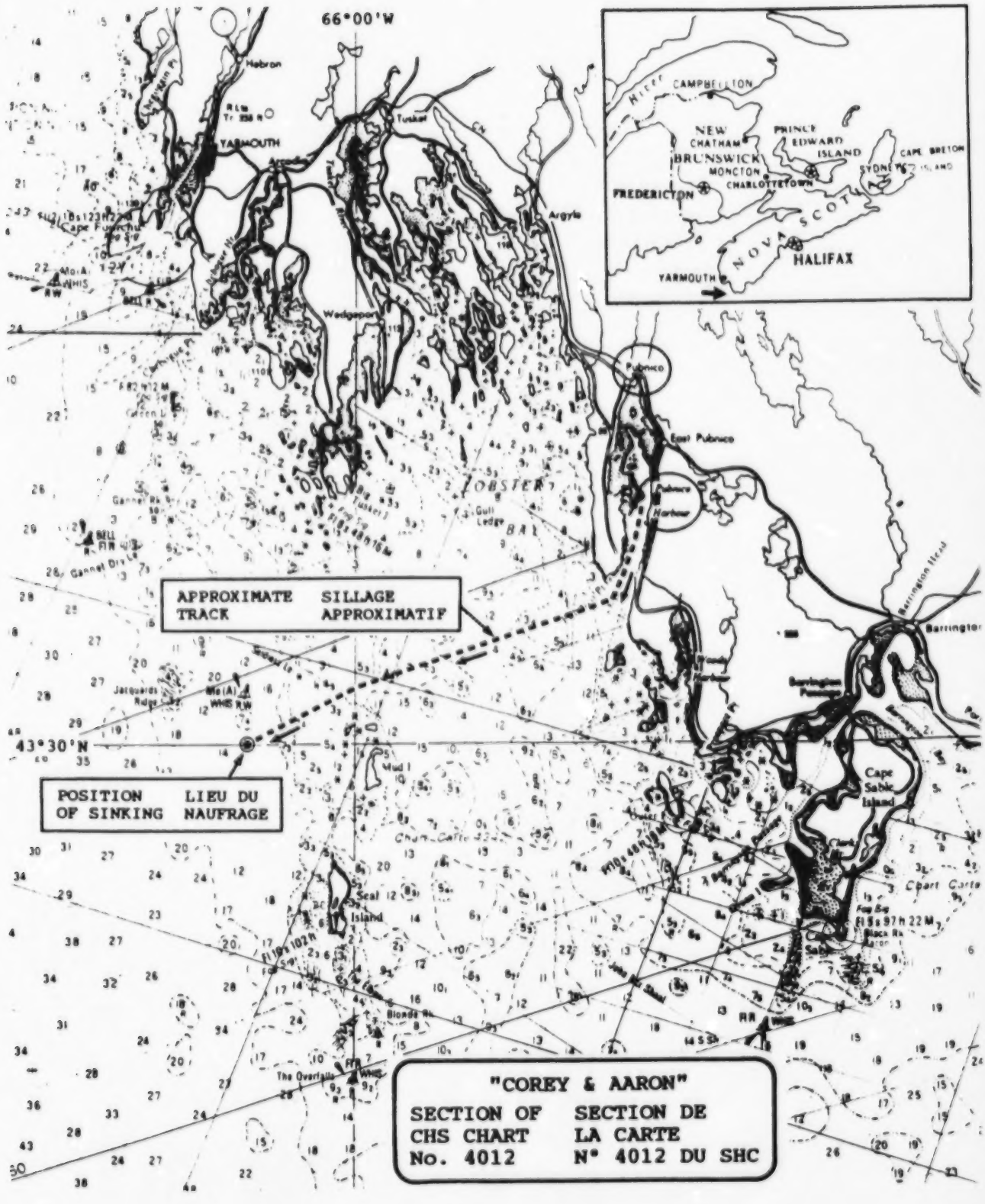
None of the crew of the "COREY AND AARON" held a Restricted Radiotelephone Operator's Certificate (Maritime) as required by the General Radio Regulations.

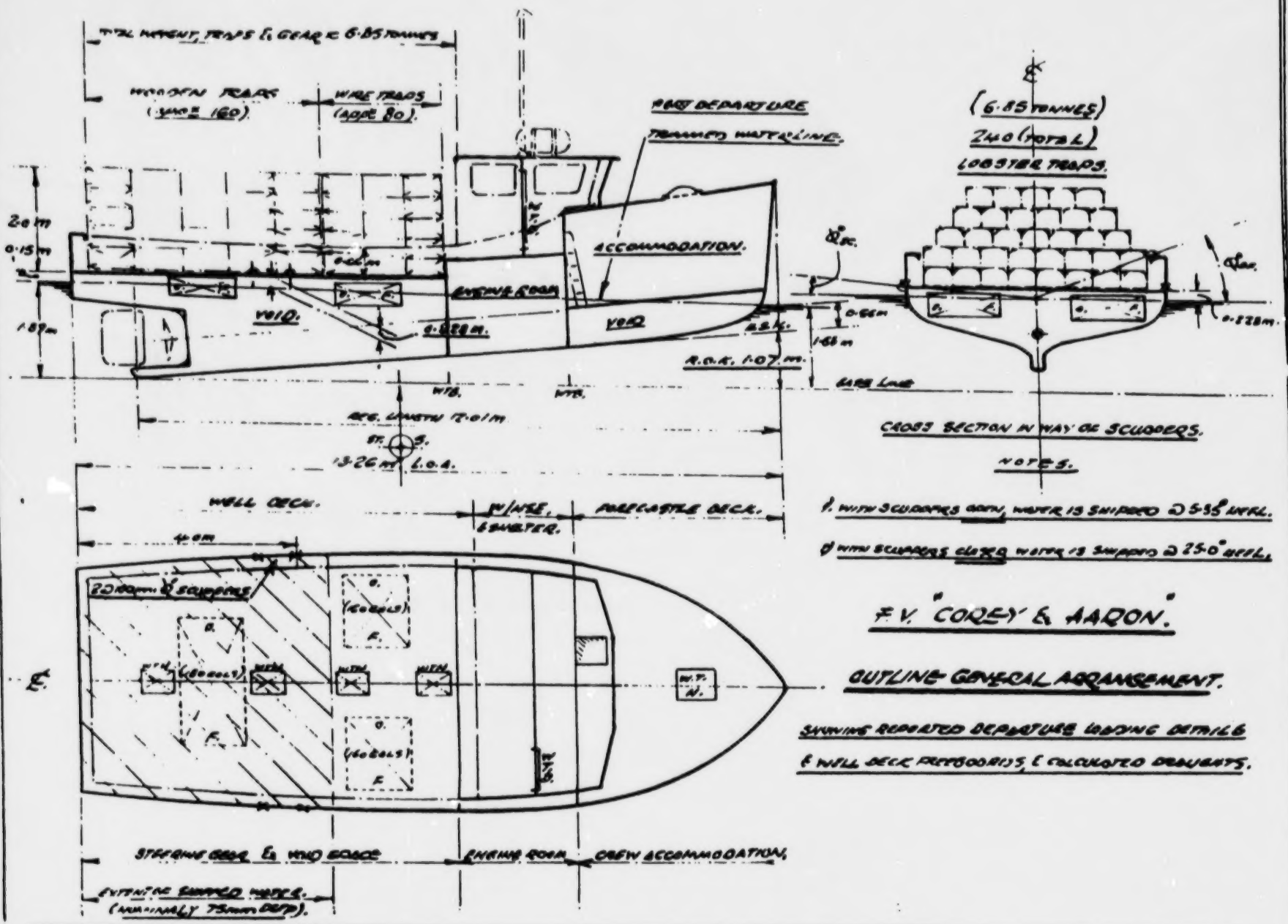
The initial Distress Call was not made on the designated Distress frequency of Channel 16.

**OTTAWA, ONTARIO**
**OCTOBER, 1988.**

## Glossary

| | |
|---|---|
| Beams | Transverse structural members which support decks |
| Bulkheads | Vertical partitions (walls) separating compartments |
| Deep floors | Transverse structural members in the bottom of a vessel |
| EPIRB | Emergency position indicating radio beacon |
| Freeboard | The vertical distance at the vessel's side from the water-line to the gunwale |
| Gunwale | The upper edge of an open boat's side |
| GMf | Transverse metacentric height, is a measure of the vessel's ability to return to the upright from small angles of heel |
| GZf | Righting lever, is a measure of the vessel's ability to return to the upright from large angles of heel |
| List | The inclination from the upright due to the asymmetric athwartship distribution of weights |
| 'MAYDAY' | International radio distress signal |
| Pitch | Movement of a vessel about the transverse horizontal axis |
| Rake of keel | Inclination from the horizontal of a vessel's keel, when floating at designed level trim |
| Scantlings | Dimensions of structural parts |
| Scupper hole | Drain hole cut through shell to allow water to run directly overboard |
| UTC | Co-ordinated Universal Time |
| VHF | Very High Frequency |


66°00'W
43°30'N
APPROXIMATE TRACK
SILLAGE APPROXIMATIF
POSITION OF SINKING
LIEU DU NAUFRAGE
"COREY & AARON"
SECTION OF CHS CHART No. 4012
SECTION DE LA CARTE N° 4012 DU SHC
YARMOUTH
Hebron
Tusket
Argyle
Wedgeport
Pubnico
East Pubnico
LOBSTER BAY
Barrington
Cape Sable Island
Seal Island
Jacquards Ridge
Gannet Rk
Gannet Dry Ledge
Gull Ledge
The Overfalls
Blonde Rk
Mud I
Green L
Cape Fourchu
HIGH CAMPBELLTON
NEW BRUNSWICK
CHATHAM
MONCTON
FREDERICTON
PRINCE EDWARD ISLAND
CHARLOTTETOWN
SYDNEY
CAPE BRETON ISLAND
NOVA SCOTIA
HALIFAX
YARMOUTH




# F.V. "COREY & AARON."

## OUTLINE GENERAL ARRANGEMENT.

SHOWING REPORTED DEPARTURE LOADING DETAILS & WELL DECK FREEBOARDS & CALCULATED DRAUGHTS.

ANNEX I

CHAPTER 1486

CANADA SHIPPING ACT

## Small Fishing Vessel Inspection Regulations

REGULATIONS RESPECTING THE CONSTRUCTION AND INSPECTION OF FISHING VESSELS NOT EXCEEDING 24.4 m REGISTERED LENGTH THAT DO NOT EXCEED 150 TONS, GROSS TONNAGE

*Short Title*

1. These Regulations may be cited as the *Small Fishing Vessel Inspection Regulations*.

.29.1(1)' Subject to subsections (2) to (4), where bulwarks on weather parts of the working deck of a fishing vessel form wells, the minimum freeing port area, expressed in square metres, in respect of each such bulwark shall be not less than

(*a*) 0.7 + 0.035 *l*, where *l* is 20 m or less, and

(*b*) 0.07 *l*, where *l* exceeds 20 m,

where *l*, expressed in metres, is the lesser of the length of bulwark in the well and 70 per cent of the length of the vessel.

(2) Where the height of the bulwark in a well on the working deck is more than 1,200 mm, the minimum freeing port area shall be increased, for each 100 mm in excess of 1,200 mm, by 0.004 $m^2$ per metre of length of well.

(3) Where the height of the bulwark in a well on the working deck is less than 900 mm, the minimum freeing port area may be decreased, for each 100 mm less than 900 mm, by 0.004 $m^2$ per metre of length of well.

(4) Where the vessel's sheer is such that the minimum freeing port areas, calculated in accordance with subsections (1) to (3), do not provide rapid and effective freeing of water from the deck, those areas shall be increased by such amount as will provide rapid and effective freeing of water from the deck.

(5) The freeing ports of every fishing vessel shall be arranged along the length of bulwarks so as to provide rapid and effective freeing of water from the deck of the vessel, and the lower edges of the freeing ports shall be as close to the deck as possible.

(6) On every fishing vessel, poundboards shall be stowed, and means of stowage of fishing gear shall be arranged, in such a manner that the effectiveness of the freeing ports of the vessel is not impaired.

(7) Every poundboard on a fishing vessel shall be so constructed that it can be secured in position when in use and will not hamper the rapid and effective freeing of water from the deck of the vessel.

(8) Every freeing port over 300 mm in depth of a fishing vessel, shall be fitted with bars spaced not more than 230 mm apart, or with other suitable protective devices.

APPENDICE I

CHAPITRE 1486

LOI SUR LA MARINE MARCHANDE DU CANADA

## Règlement sur l'inspection des petits bateaux de pêche

RÈGLEMENT CONCERNANT LA CONSTRUCTION ET L'INSPECTION DES BATEAUX DE PÊCHE D'UNE LONGUEUR RÉGLEMENTAIRE D'AU PLUS 24,4 m ET D'UNE JAUGE BRUTE D'AU PLUS 150 TONNEAUX

*Titre abrégé*

1. Le présent règlement peut être cité sous le titre: *Règlement sur l'inspection des petits bateaux de pêche*.

29.1(1) Sous réserve des paragraphes (2) à (4), lorsque les pavois sur les parties exposées du pont de travail d'un bateau de pêche forment des puits, la section minimale des sabords de dégagement, exprimée en mètres carrés, concernant chaque pavois ne sera pas inférieure à:

*a*) 0,7 + 0,035 *l*, lorsque *l* est de 20 m ou moins, et

*b*) 0,07*l*, lorsque *l* dépasse 20 m

lorsque *l*, exprimé en mètres, est moindre que la longueur de pavois dans le puits et 70 pour cent de la longueur du navire.

(2) Lorsque la hauteur du pavois dans un puits sur le pont de travail a plus de 1 200 mm, la section minimale des sabords de dégagement peut être augmentée, pour chaque tranche de 100 m de plus de cette hauteur, de 0,004 $m^2$ par mètre de longueur de puits.

(3) Lorsque la hauteur du pavois dans un puits sur le pont de travail a moins de 900 m, la section minimale des sabords de dégagement peut être réduite, pour chaque tranche complète ou incomplète de 100 mm de cette hauteur, de 0,004 $m^2$ par mètre de longueur de puits.

(4) Lorsque la tonture du bateau est telle que les sections minimales de sabords de dégagement, calculées selon les paragraphes (1) à (3), ne permettent pas une évacuation rapide et efficace de l'eau sur le pont, il faudra augmenter ces sections d'une valeur telle qu'elles puissent permettre l'évacuation rapide et efficace de l'eau sur le pont.

(5) Sur tout bateau de pêche, les sabords de dégagement doivent être disposés le long des pavois de façon à permettre une évacuation rapide et efficace de l'eau sur le pont du navire, et les bords inférieurs des sabords de dégagement doivent se trouver aussi près que possible du pont.

(6) Sur tout bateau de pêche, les planches de séparation doivent être saisies, et les dispositifs de saisissage des engins de pêche doivent être arrangés de façon à ne pas nuire à l'efficacité des sabords de dégagement du navire.

(7) Les planches de séparation sur un bateau de pêche doivent être construites de façon à pouvoir être saisies en place lors de leur utilisation et à ne pas empêcher l'écoulement rapide et efficace de l'eau du pont du navire.

(8) Les sabords de dégagement de plus de 300 mm de profondeur sur un bateau de pêche doivent être munis de barres espacées de 230 mm au plus ou de tout autre dispositif de protection approprié.

(9) Where the protective devices fitted in accordance with subsection (8) are covers, they shall be of a construction approved by the Minister.

(10) In a fishing vessel intended to operate in areas subject to icing, protective devices fitted in accordance with subsection (8) shall be capable of being easily removed to restrict or reduce ice accretion."

*Life Saving Equipment*

30. (1) In this section and in section 31, "approved", when used in reference to an article, means that the article has been built in accordance with the standards therefor in the *Life Saving Equipment Regulations* and has been approved by the Board.

(2) Every fishing vessel of open construction not exceeding 12.2 m in length shall carry

(*a*) one approved life jacket for each person on board; and

(*b*) one approved lifebuoy fitted with 27 m of line.

(9) Lorsque les dispositifs de protection installés conformément aux dispositions du paragraphe (8) sont des tampons, ils doivent être de construction approuvée par le Ministre.

(10) Sur les bateaux de pêche destinés à naviguer dans des zones de givrage, il devra être possible d'enlever facilement les dispositifs de protection installée conformément aux dispositions du paragraphe (8) pour restreindre ou réduire l'accumulation de glace.»

*Équipement de sauvetage*

30. (1) Dans le présent article et à l'article 31, l'expression «approuvé», appliquée à un objet, signifie que l'objet a été construit conformément aux normes applicables, établies dans le *Règlement sur l'équipement de sauvetage*, et qu'il a été approuvé par le Bureau.

(2) Tout bateau de pêche non ponté ne dépassant pas 12,2 m de longueur doit avoir

*a*) un gilet de sauvetage approuvé pour chaque personne à bord; et

*b*) une bouée de sauvetage approuvée munie d'une ligne de 27 m..

ANNEX II

# Stability, Subdivision, and Load Line Standards.

## INTRODUCTION

The standards outlined in this booklet have been developed by the Board of Steamship Inspection, Department of Transport, and indicate conditions of approval and criteria used by the approval authority in assessing submissions required by regulations written under the Canada Shipping Act.

The criteria outlined in the various standards denote minimum requirements with no maximum limits having been set. The standards are intended to supplement the regulations in matters of detail to ensure uniform minimums across the country and to give a base from which shipowners, shipbuilders, and designers may work.

## STANDARD: STAB 4

## STABILITY STANDARDS FOR FISHING VESSELS:

(a) subject to compliance with the Large Fishing Vessel Inspection Regulations, or

(b) required to submit stability data by the Small Fishing Vessel Inspection Regulations.

### OPERATING CONDITIONS WITH NO ACCUMULATED ICE

1 The following minimum intact stability criteria are to be used in the approval of stability data for the above vessels:

(i) The area under the righting lever (GZ) curve should not be less than 0.055 metre-radians up to $\phi = 30^\circ$ angle of heel, and not less than 0.09 metre-radians up to $\phi = 40^\circ$, or the angle or downflooding $\phi_f$ if this angle is less than $40^\circ$.

Additionally, the area under the righting lever (GZ) curve between the angles of heel of $30^\circ$ and $40^\circ$ or between $30^\circ$ and $\phi_f$ if this angle is less than $40^\circ$, should not be less than 0.03 metre-radians.

(ii) The righting lever GZ should be at least 0.20 metres at an angle of heel equal to or greater than $30^\circ$.

(iii) The maximum righting arm should occur at an angle of heel preferably exceeding $30^\circ$ but not less than $25^\circ$.

(iv) The initial metacentric height(GM) should not be less than 0.35 metres.

WORST OPERATING CONDITION WITH ACCUMULATED ICE

2 Using the ice accumulation weights and vertical centres of gravity required by the appropriate fishing vessel inspection regulations:

(i) The area under the righting lever (GZ) curve should not be less than 0.04 metre-radians up to 30 degrees angle of heel and not less than 0.058 metre-radians up to 40 degrees or the angle of downflooding if this angle is less than 40 degrees.

Additionally, the area under the righting lever (GZ) curve between the angles of heel of 30 degrees and 40 degrees or between 30 degrees and the angle of downflooding, if this angle is less than 40 degrees, should not be less than 0.016 metre-radians.

(ii) The righting lever (GZ) should be at least 0.15 metres at an angle of heel equal to or greater than 20 degrees.

(iii) The maximum righting lever (GZ) should occur at an angle of heel not less than 20 degrees.

(iv) The initial metacentric height (GM) should not be less than 0.23 metres.

3 Hydrostatic and stability curves should normally be prepared on a designed trim basis. However, where the operating trim or the form and arrangement of the ship are such that change in trim has an appreciable effect on righting arms, such change of trim is to be taken into account.

4 The calculations may take into account the volume to the upper surface of the deck sheathing, if fitted. In the case of wood ships the dimensions should be taken to the outside of hull and deck planking.

5 Cross Curves of Stability may take the following into account and a note to this effect must be shown:

(a) Enclosed weathertight superstructures and enclosed weathertight deckhouses of similar construction,

(b) Weathertight trunks, and

(c) Hatchways having regard to the effectiveness of the closures.

6 Definitions for paragraph 5 are as follows:

SUPERSTRUCTURE - means a decked structure on the bulkhead deck extending from side to side of the ship, or with the side plating not being inboard of the shell plating more than 4 per cent of the maximum moulded breadth of the vessel measured at mid-ships. A raised quarter deck is regarded as a superstructure.

WEATHERTIGHT - means that in any sea conditions water will not penetrate into the ship.

7 In cases where a ship would flood through an opening, the stability curve is to be cut short at the corresponding angle of flooding and the ship is to be considered as having entirely lost her stability at that angle.

8 In the calculations for loading conditions an allowance is to be made for the weight of the wet fishing nets and tackle.

9 In all cases the cargo should be assumed to be homogenous unless this is inconsistent with practice.

10 The following conditions are not considered as operating conditions. Therefore the above criteria are not applicable and the standard to be obtained in these conditions is a positive GM:

(a) Lightship

(b) Port after discharge of cargo with 10% of fuel, fresh water and stores remaining and accumulated ice on top-sides and rigging.

(The lightship condition is defined as the condition of a vessel ready for sea with no stores, consumables, fluid ballast or crew on board).

"COREY & AARON"

Building just prior to completion. Note holes in bulwark ready to be fitted with scuppers.

Construction juste avant l'achèvement. Remarquez les trous dans le pavois prêts à recevoir les dalots.